



Microwave Instruments

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Instrument Status



Operations

- All three modules are fully operational

Instrument mode & state

- Normally in full scan mode
- Occasionally in warm-cal stare mode
 - S/C-safe causes MW-safe
- All three modules now use optimal space view position
 - HSB: SV4 (furthest from nadir, 11° below horizon)
 - AMSU: SV3 (next to closest to nadir, 10° below horizon)

Instrument stability

- Temperatures: very stable
 - RF-shelf temperatures vary by only fraction of a degree
- Radiometric gains: stable
 - No significant drifts seen
 - No lasting effect after cold soak (> 48 hours)

Channel	Gain
A-1	16.6
A-2	15.9
A-3	13.3
A-4	15.8
A-5	13.9
A-6	14.2
A-7	15.8
A-8	15.3
A-9	14.7
A-10	16.2
A-11	19.2
A-12	20.1
A-13	20.5
A-14	22.4
A-15	10.4
H-2	30.7
H-3	38.4
H-4	36.4
H-5	33.8

Calibration Status



Calibration algorithms

- As per ATBD
- Recently modified to compute calibration coefficients in Tb-space

Calibration parameters

- At-launch baseline tables have been updated; all now best known

Radiometric sensitivity

- Very good for all channels: all better than specs

Calibration accuracy

- Estimated at ≤ 1 K
- Aim is to improve it to ≤ 0.5 K

Summary

- Calibration is now very good; baseline performance
- Sidelobe correction not yet applied at L1b

Noise Analysis: Approach



Use warm-cal data

- No extraneous signal; instrument fluctuations only

1. Fit short-term smoothing function

- 1-2 cycle moving average
- Difference is random noise; $\sigma = \text{NEDT}$

2. Fit medium-term smoothing function

- Orbit-fraction moving average
- Difference is orbital + external signal

3. Fit long-term smoothing function

- Multiple-orbit moving average
- Difference is longitude-dependent signal

Noise Analysis: Results



Excellent radiometric sensitivity in all channels

- NEDT < T/V-results < specs

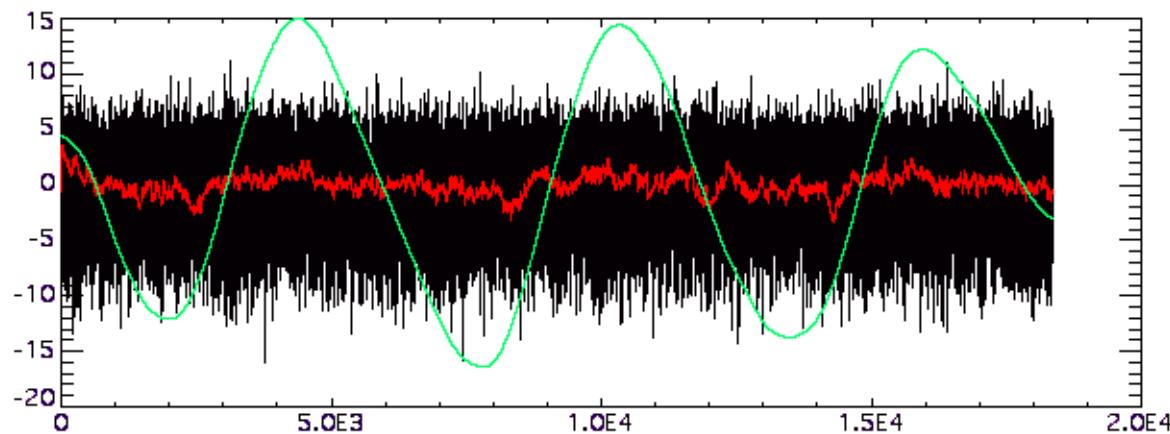
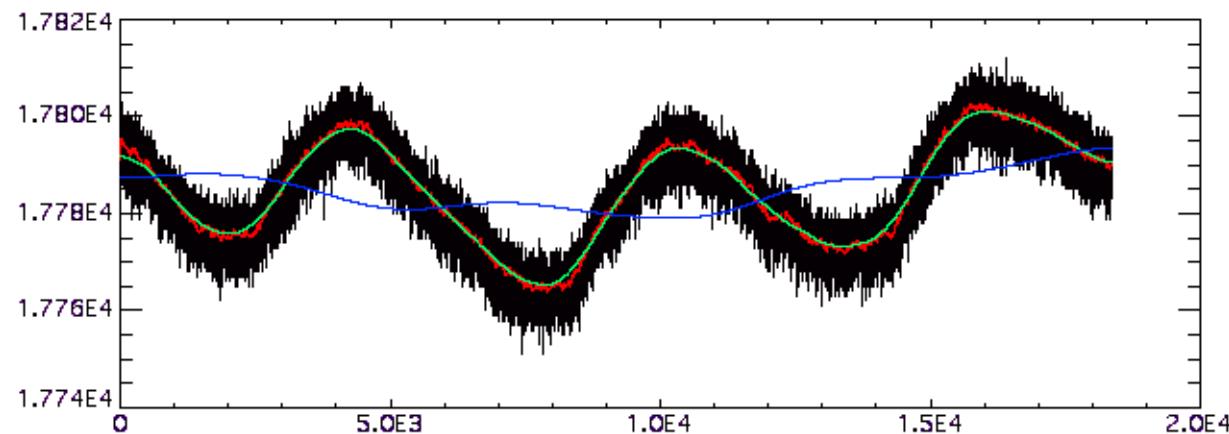
AMSU ch. 7 has additional correlated noise - USE W/CAUTION

- Average effective noise \approx 5xNEDT
- Significant orbital variations around average
- Analysis is ongoing
- Intent is to model added noise & remove as bias

Minor added noise in other AMSU channels - OK TO USE

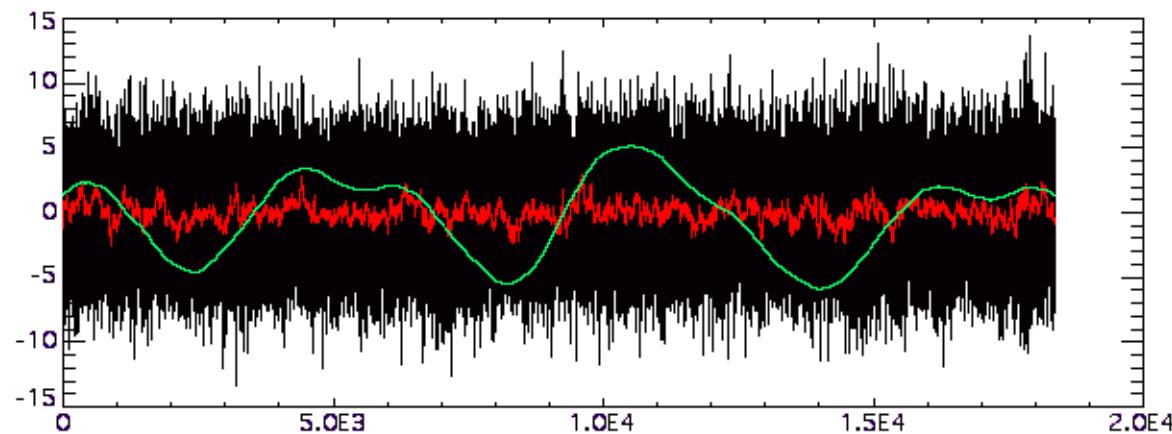
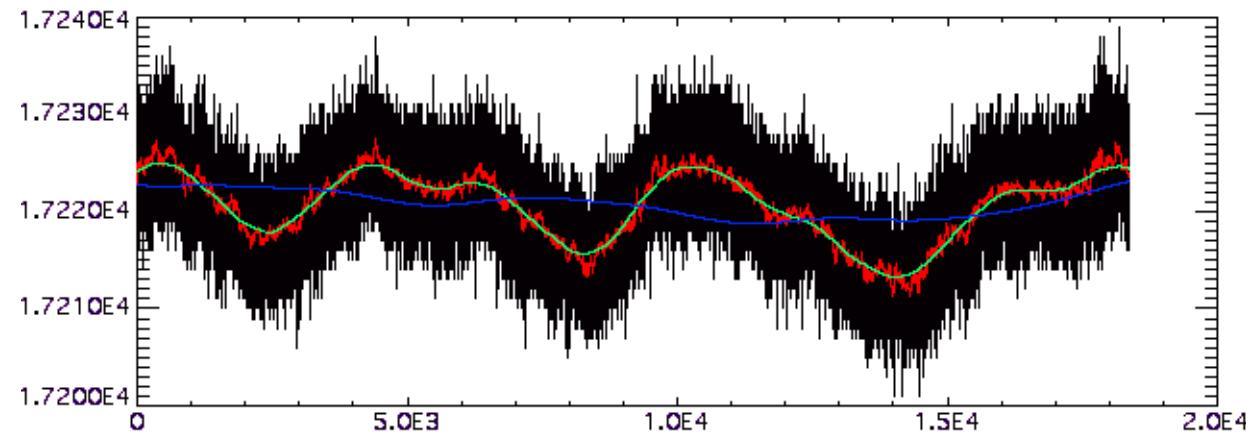
- Ch. 6: similar to ch. 7, but much smaller
- Ch. 9: occasional popping, mostly calibrated out
- Ch. 14: possible correlated noise, small

Noise Analysis: AMSU Ch. 1

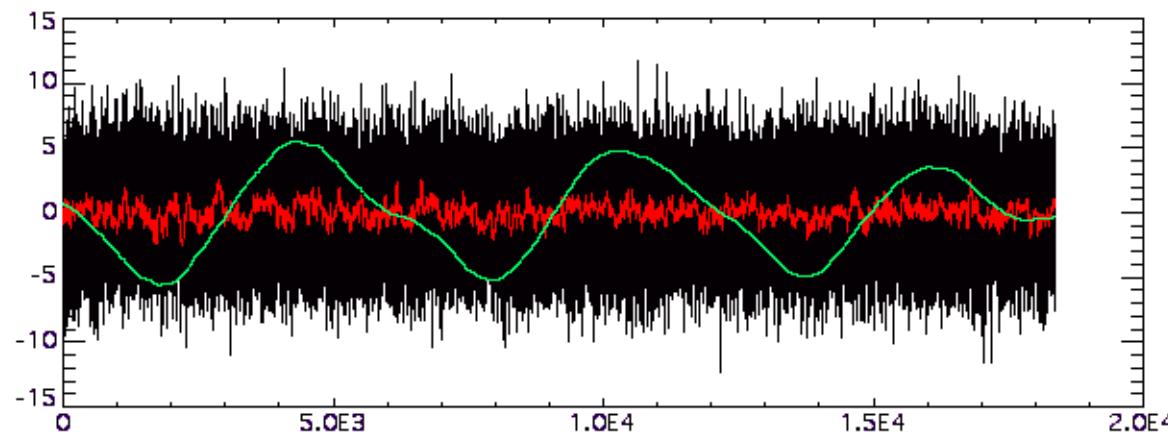
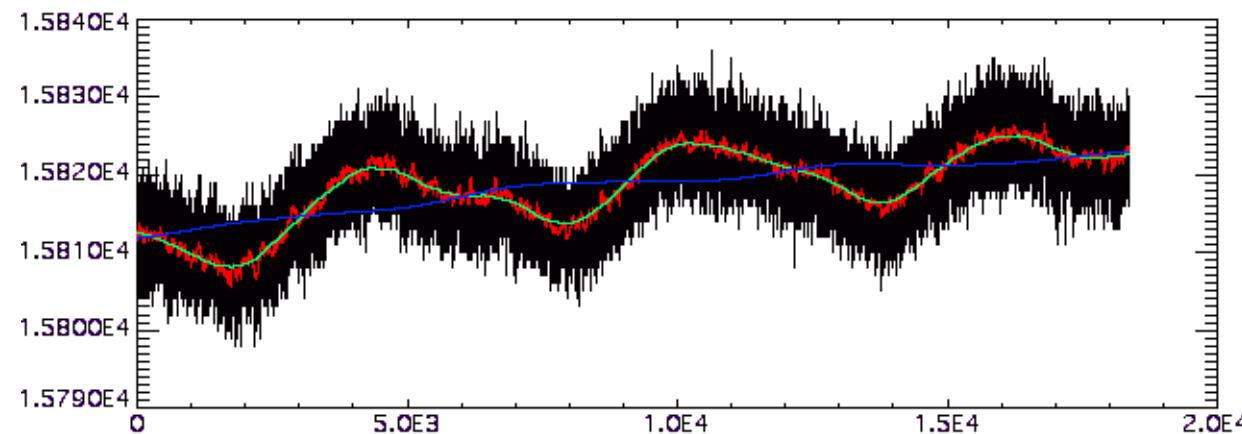




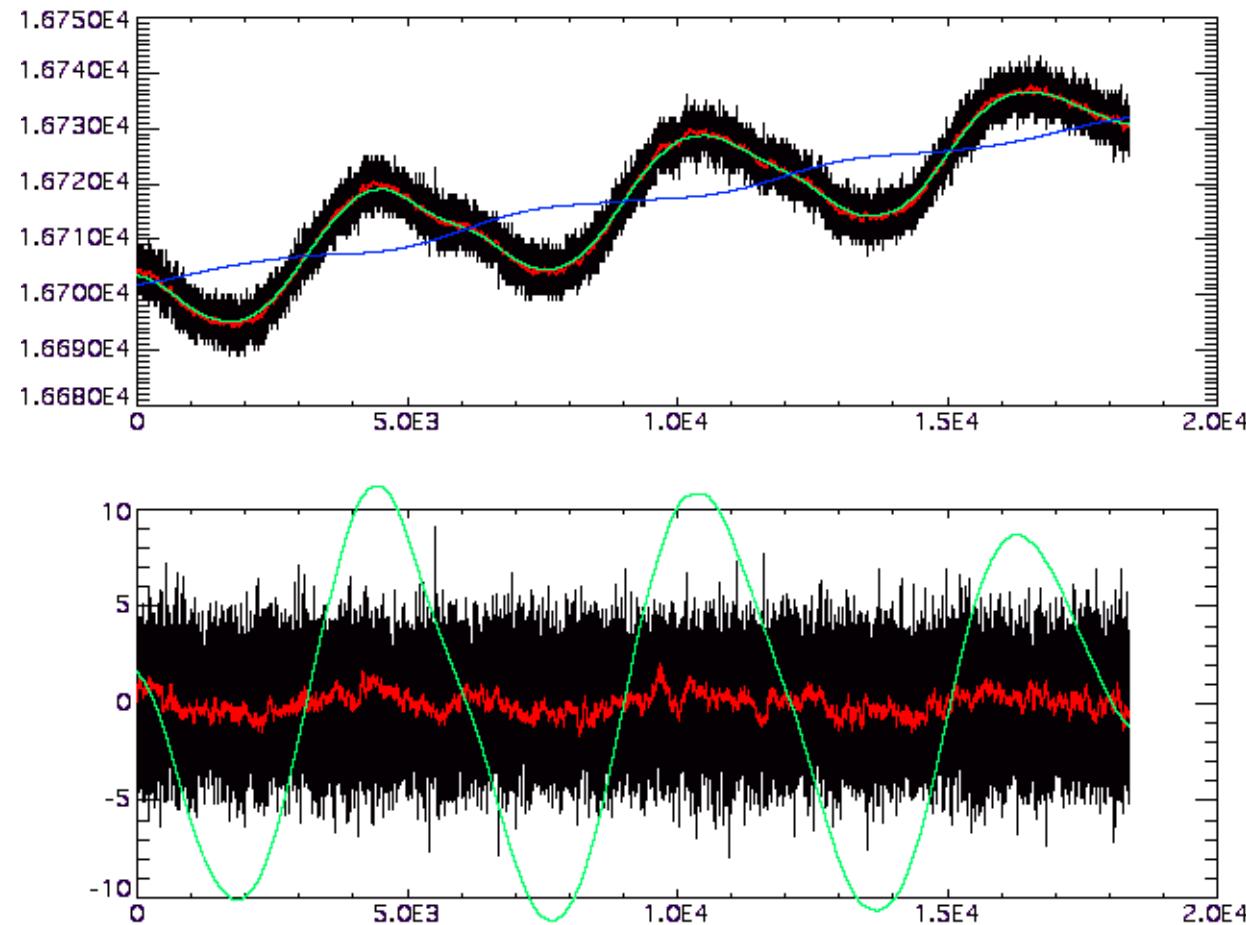
Noise Analysis: AMSU Ch. 2



Noise Analysis: AMSU Ch. 3

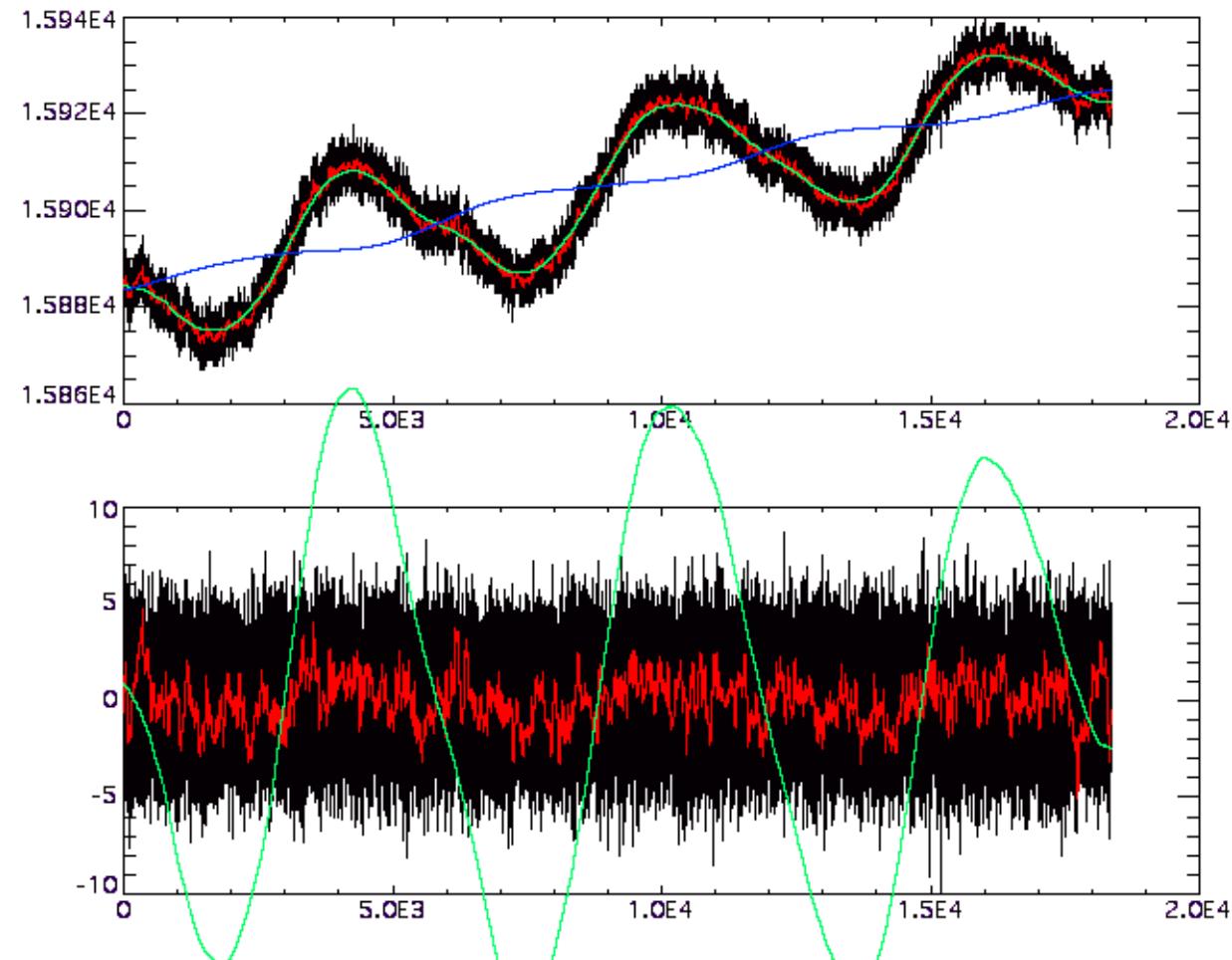


Noise Analysis: AMSU Ch. 4

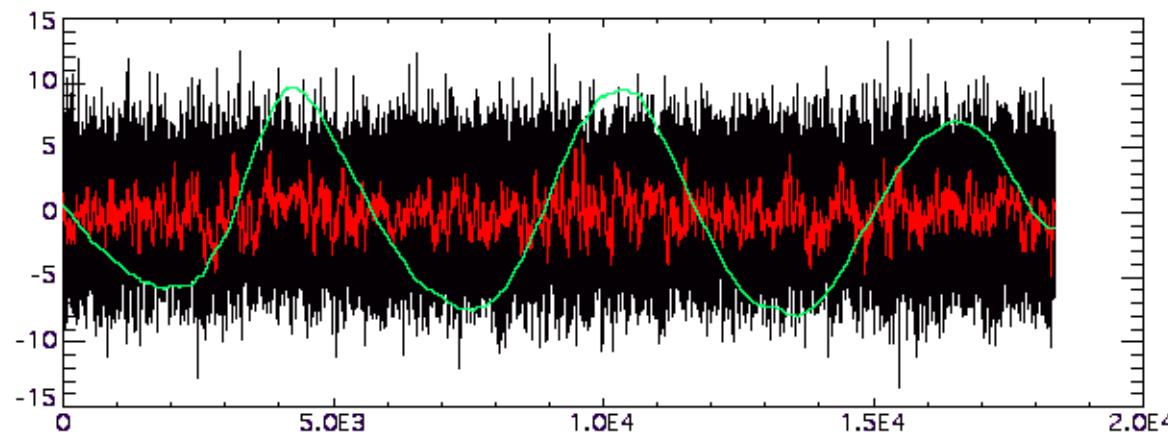
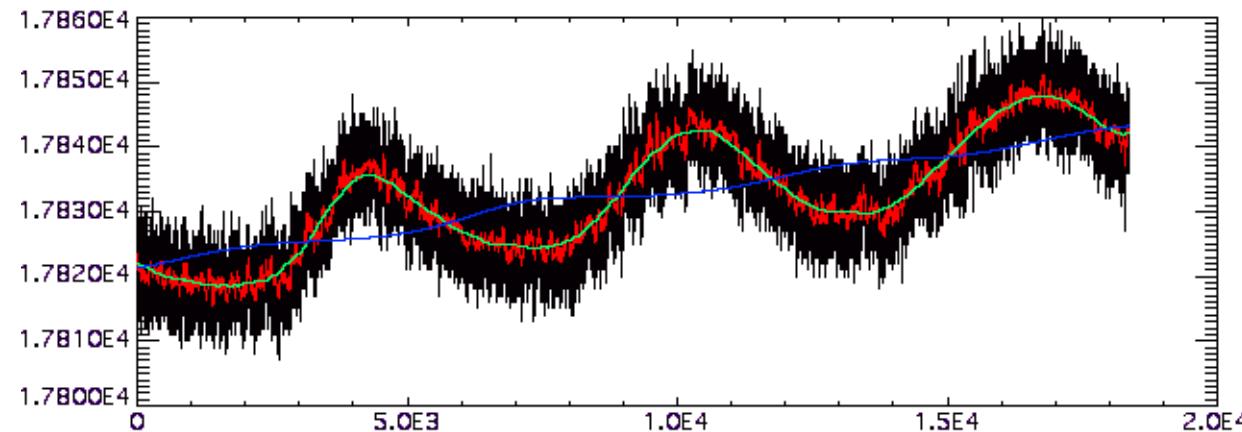




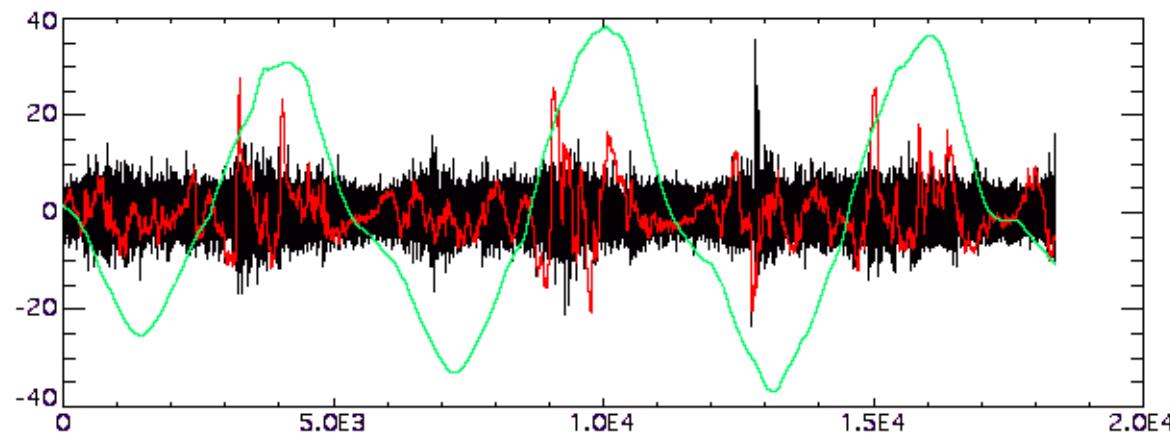
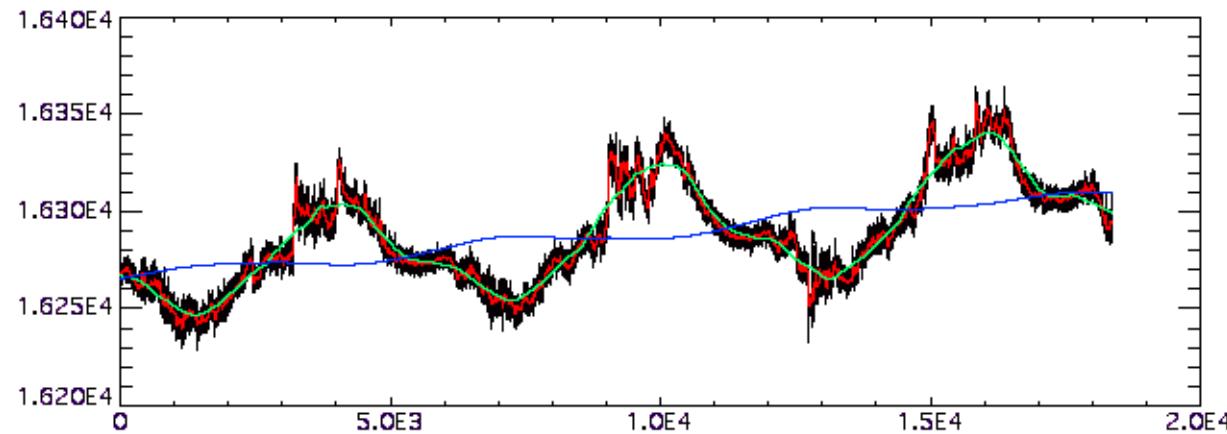
Noise Analysis: AMSU Ch. 5



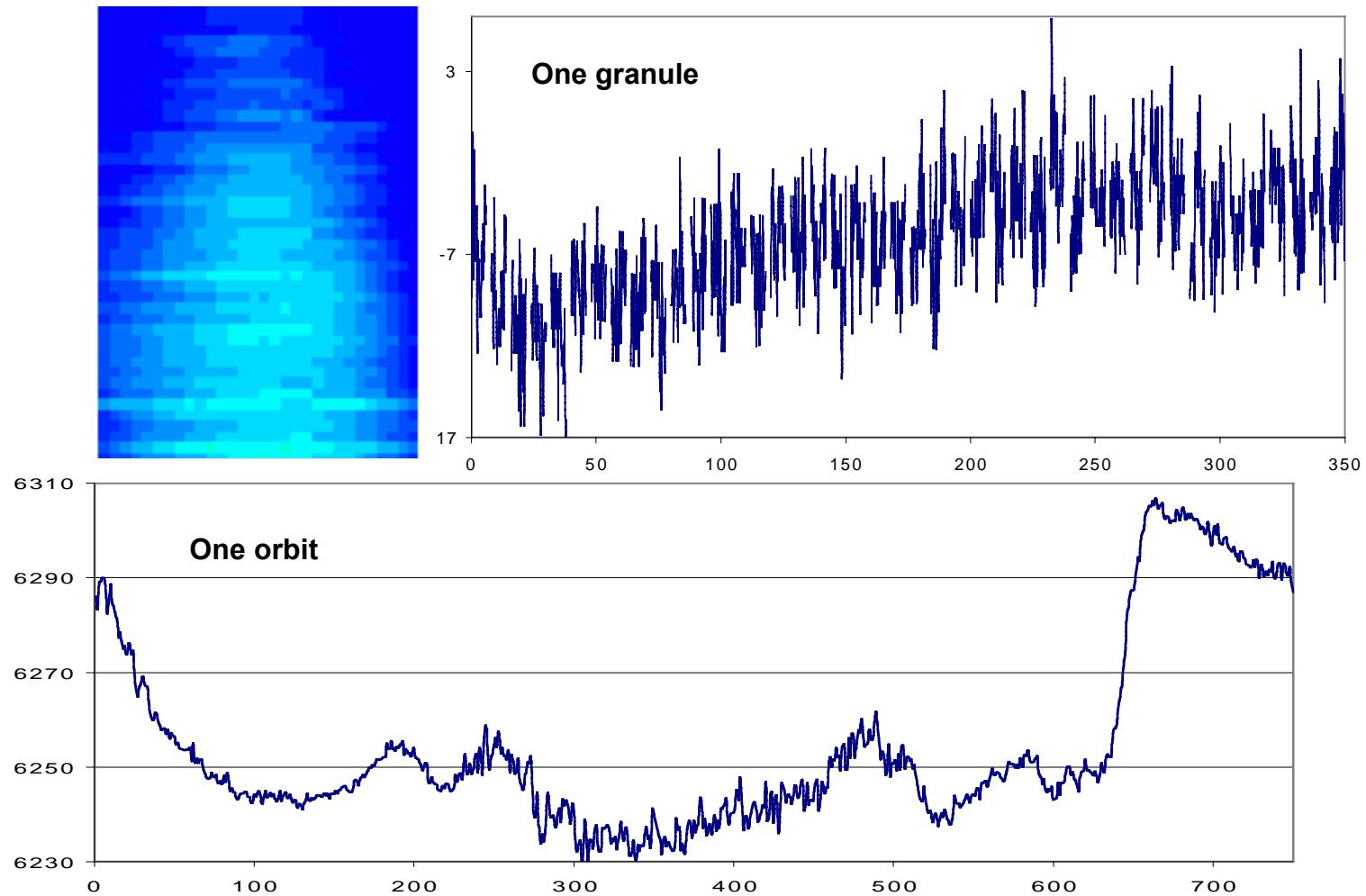
Noise Analysis: AMSU Ch. 6



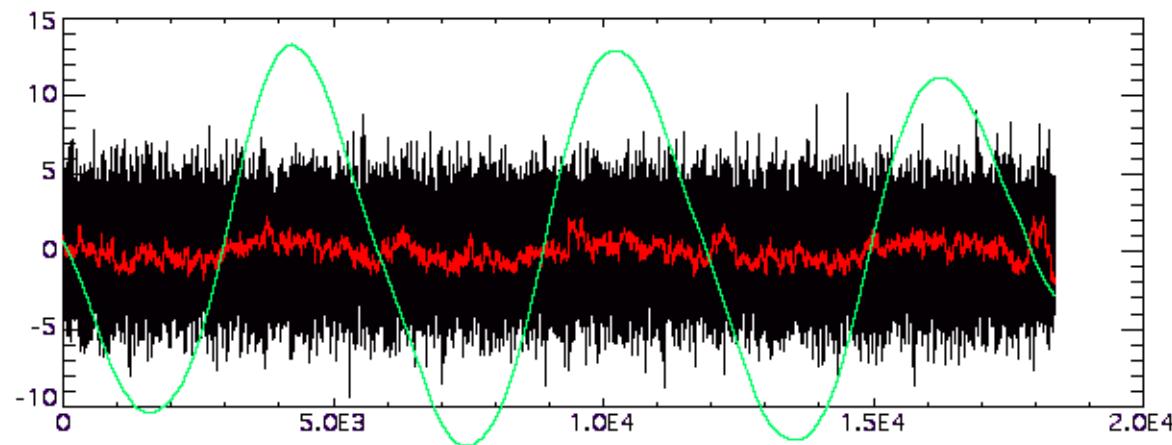
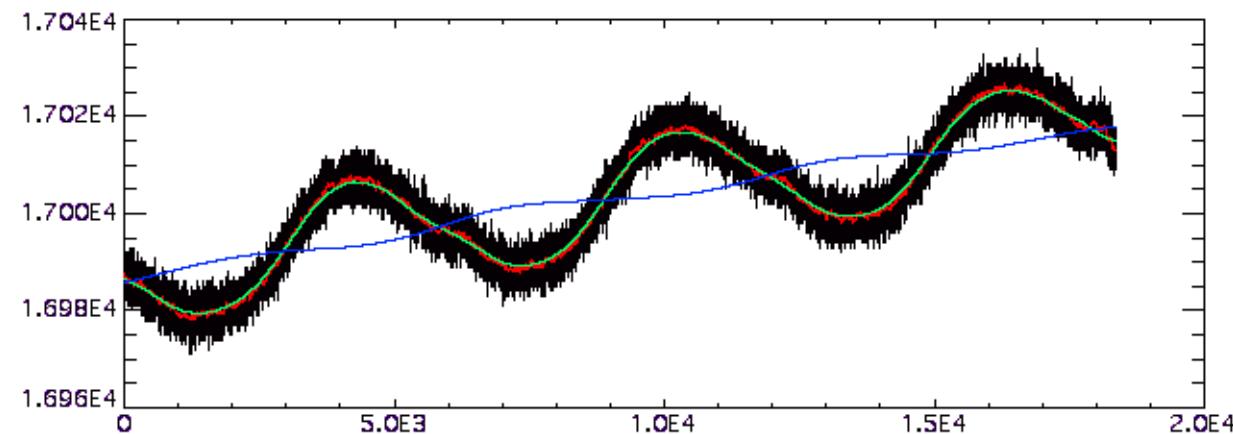
Noise Analysis: AMSU Ch. 7



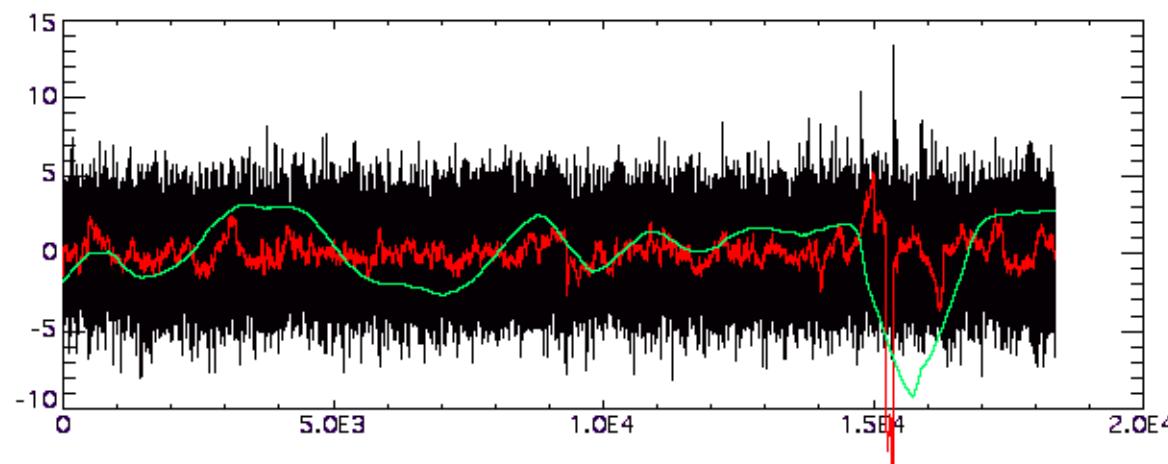
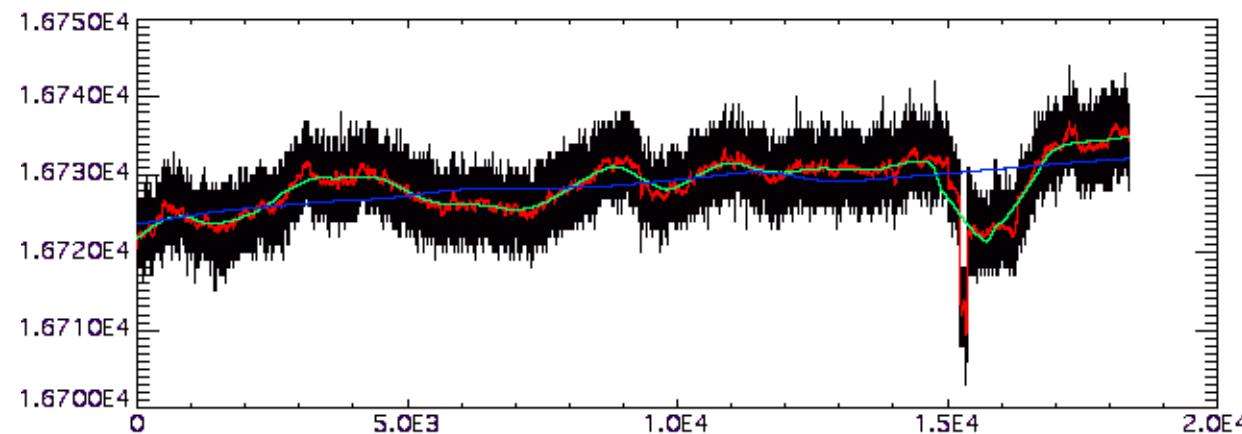
Noise Analysis: AMSU Ch. 7 Detail



Noise Analysis: AMSU Ch. 8

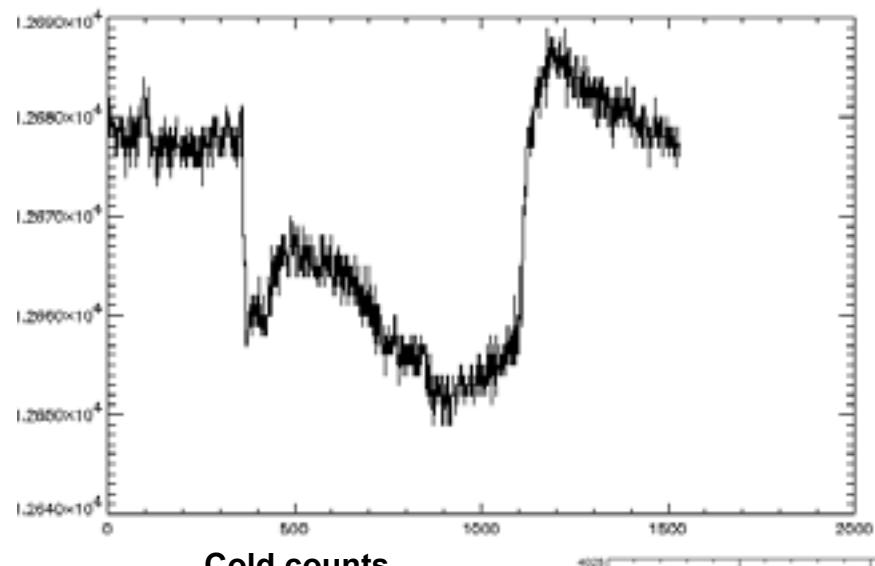


Noise Analysis: AMSU Ch. 9

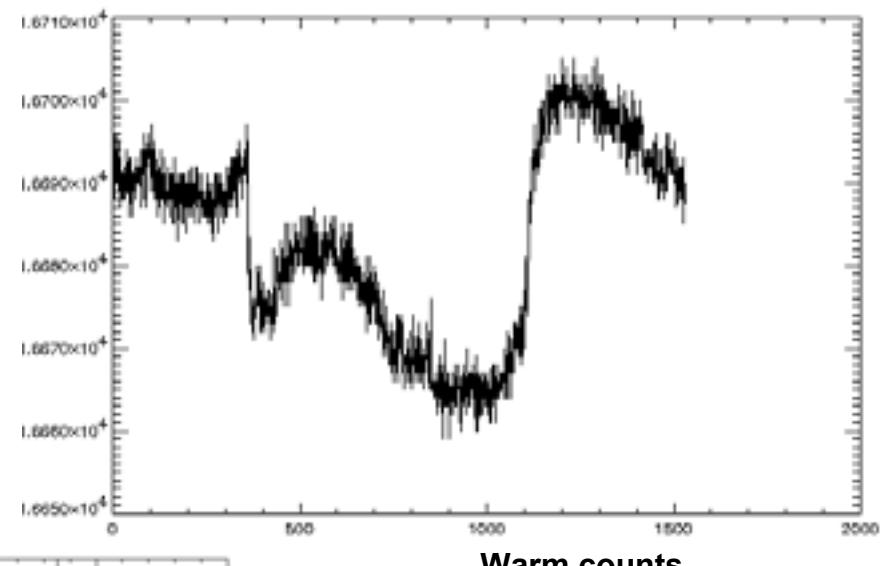




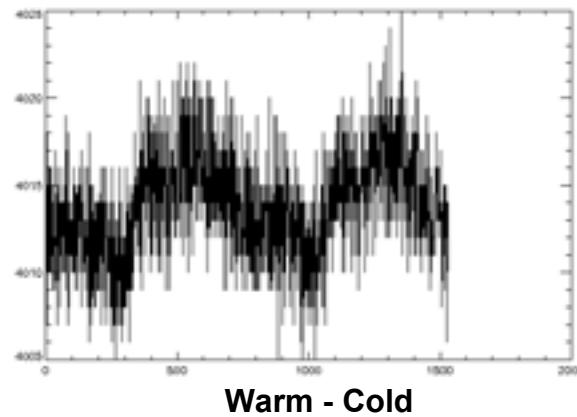
Noise Analysis: AMSU Ch. 9 Popping



Cold counts

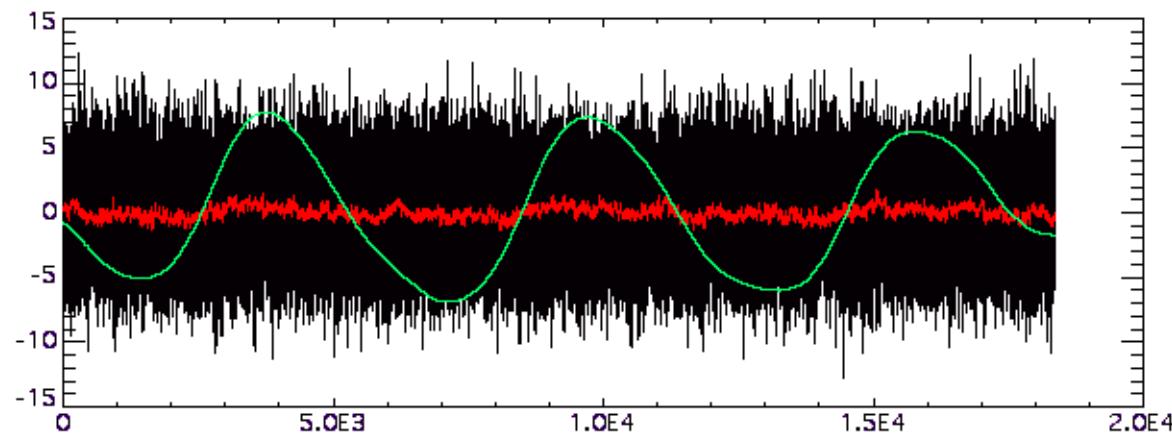
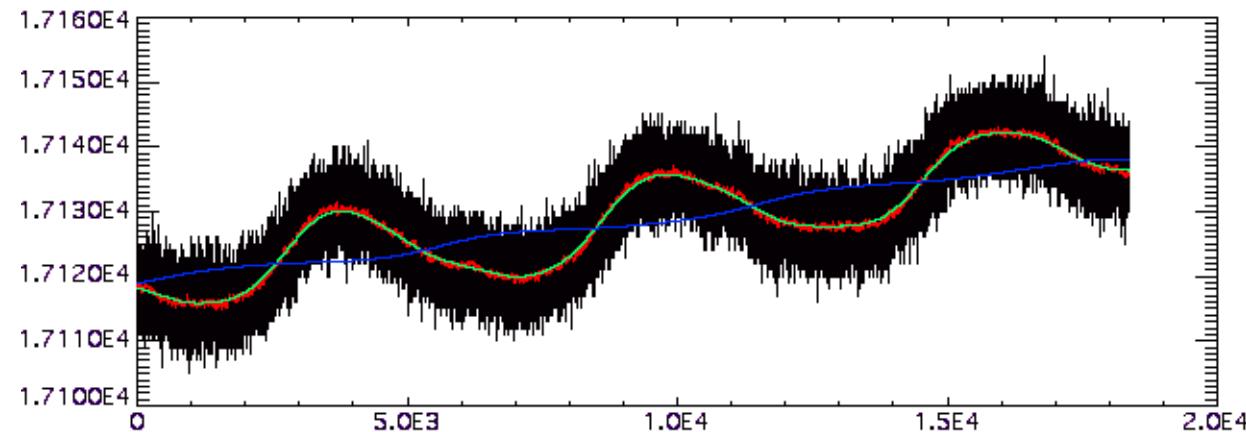


Warm counts

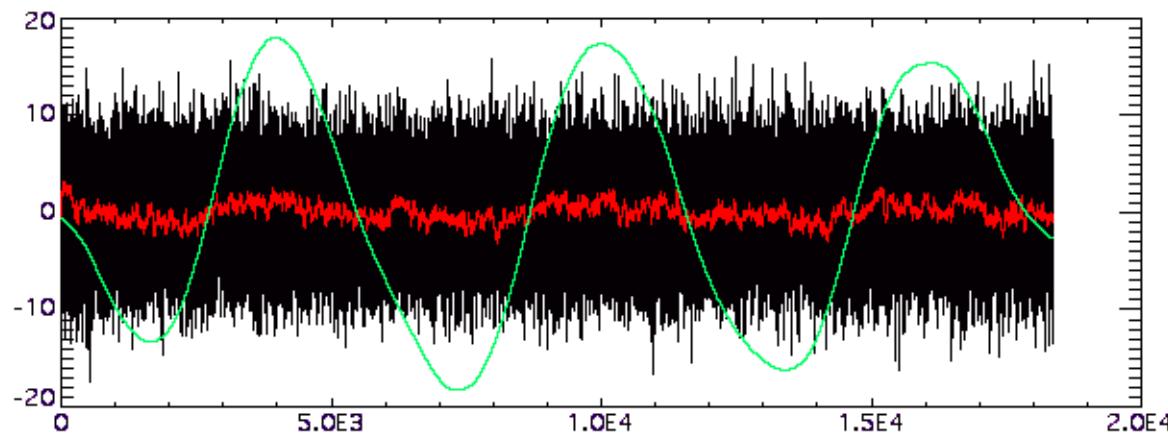
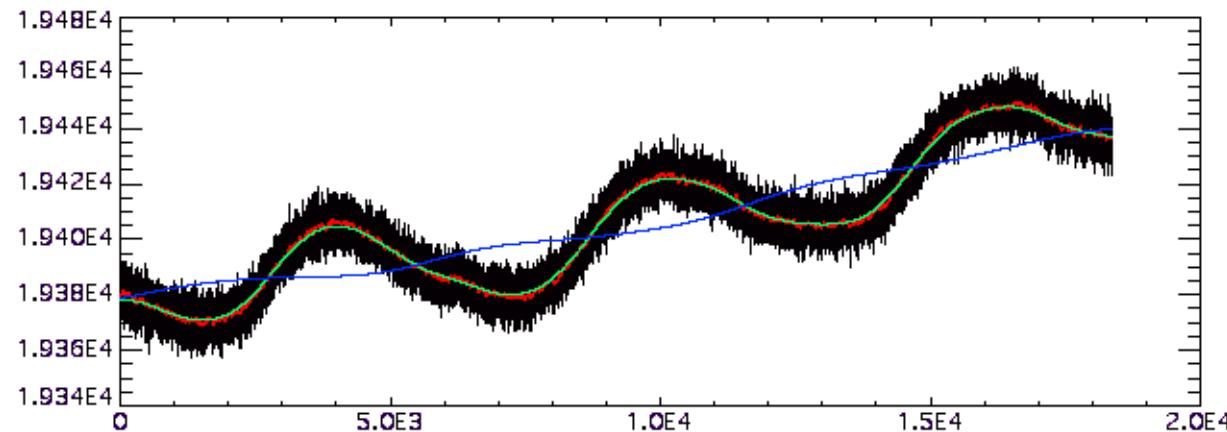


Warm - Cold

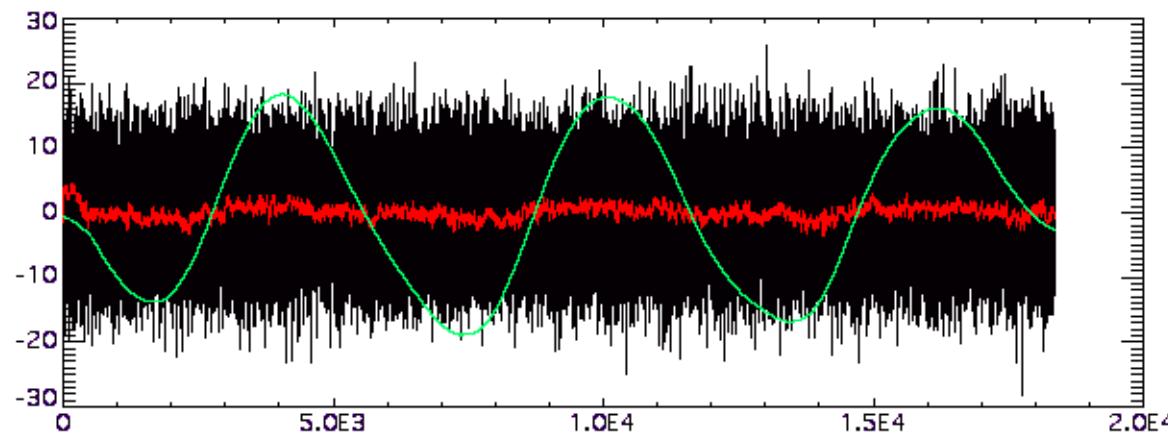
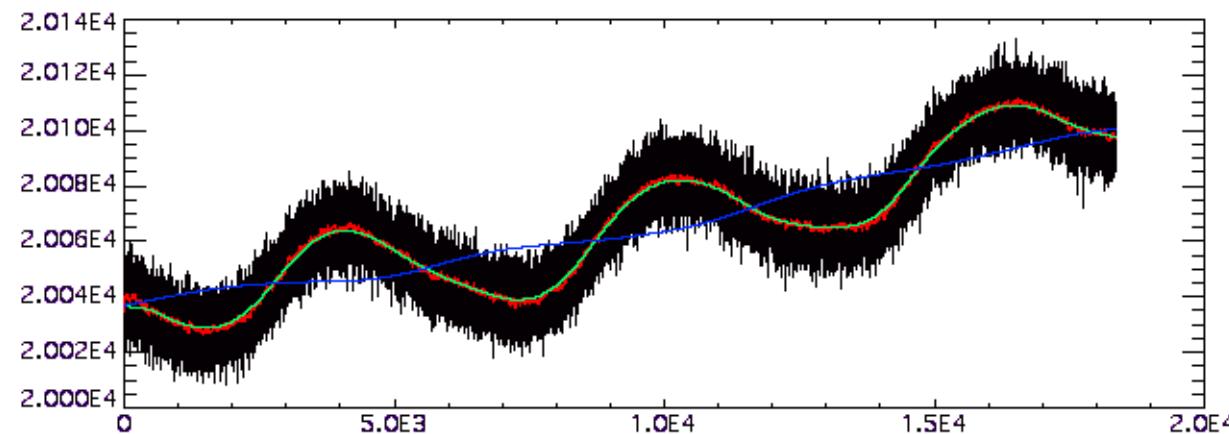
Noise Analysis: AMSU Ch. 10



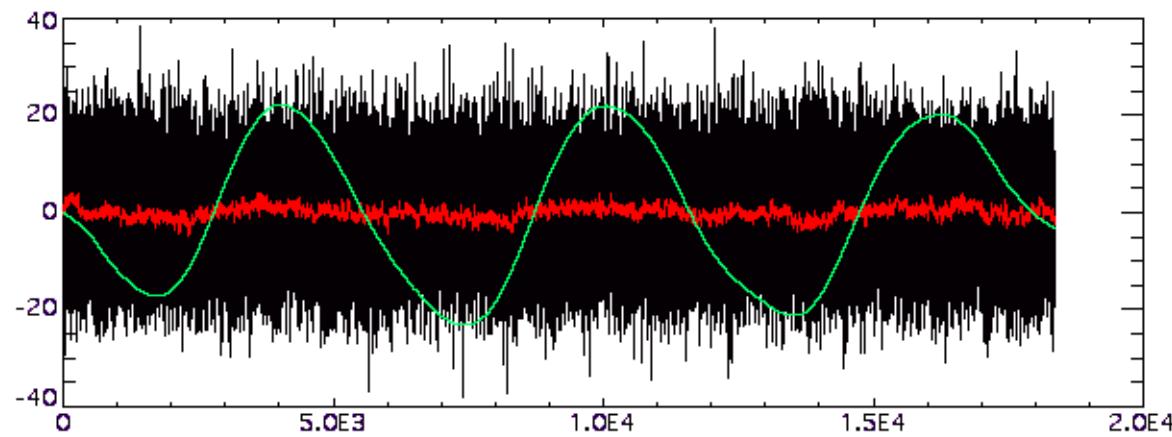
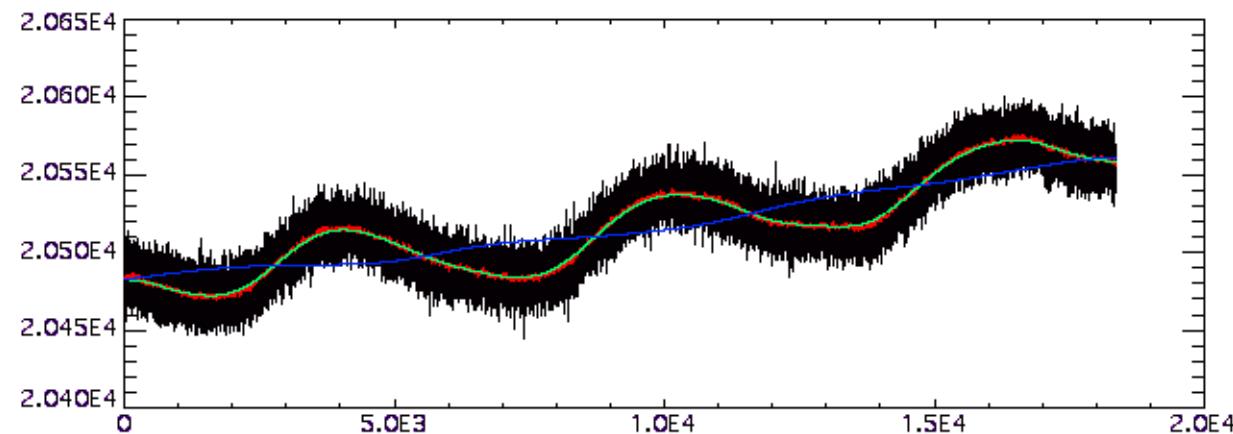
Noise Analysis: AMSU Ch. 11



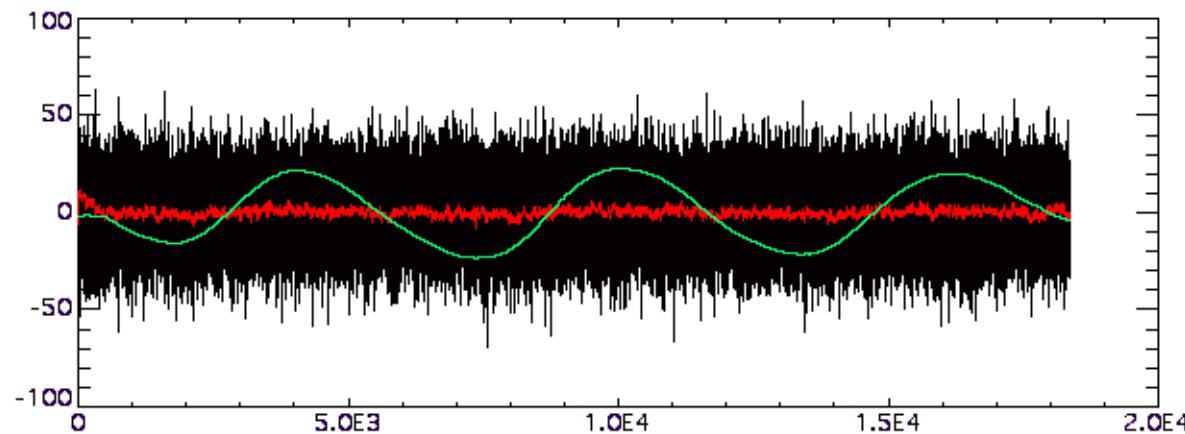
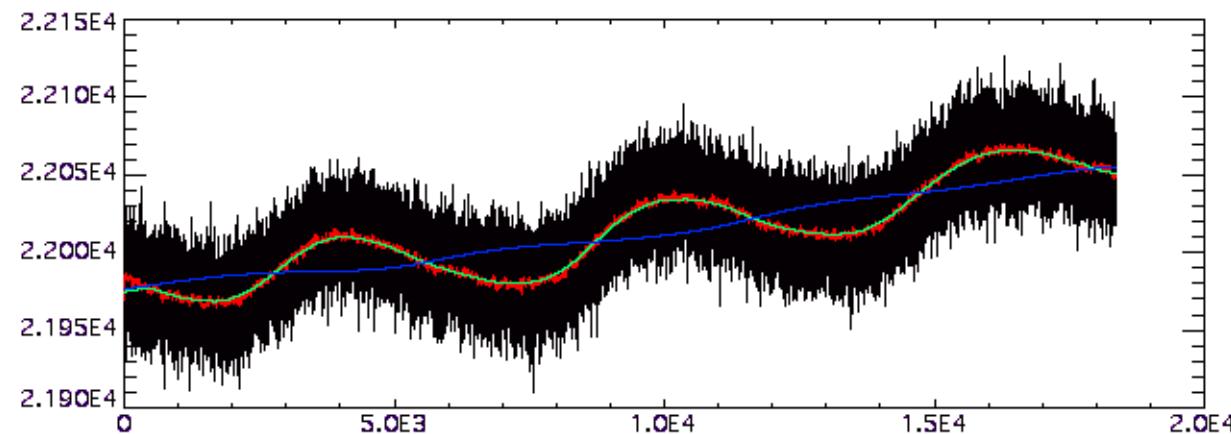
Noise Analysis: AMSU Ch. 12



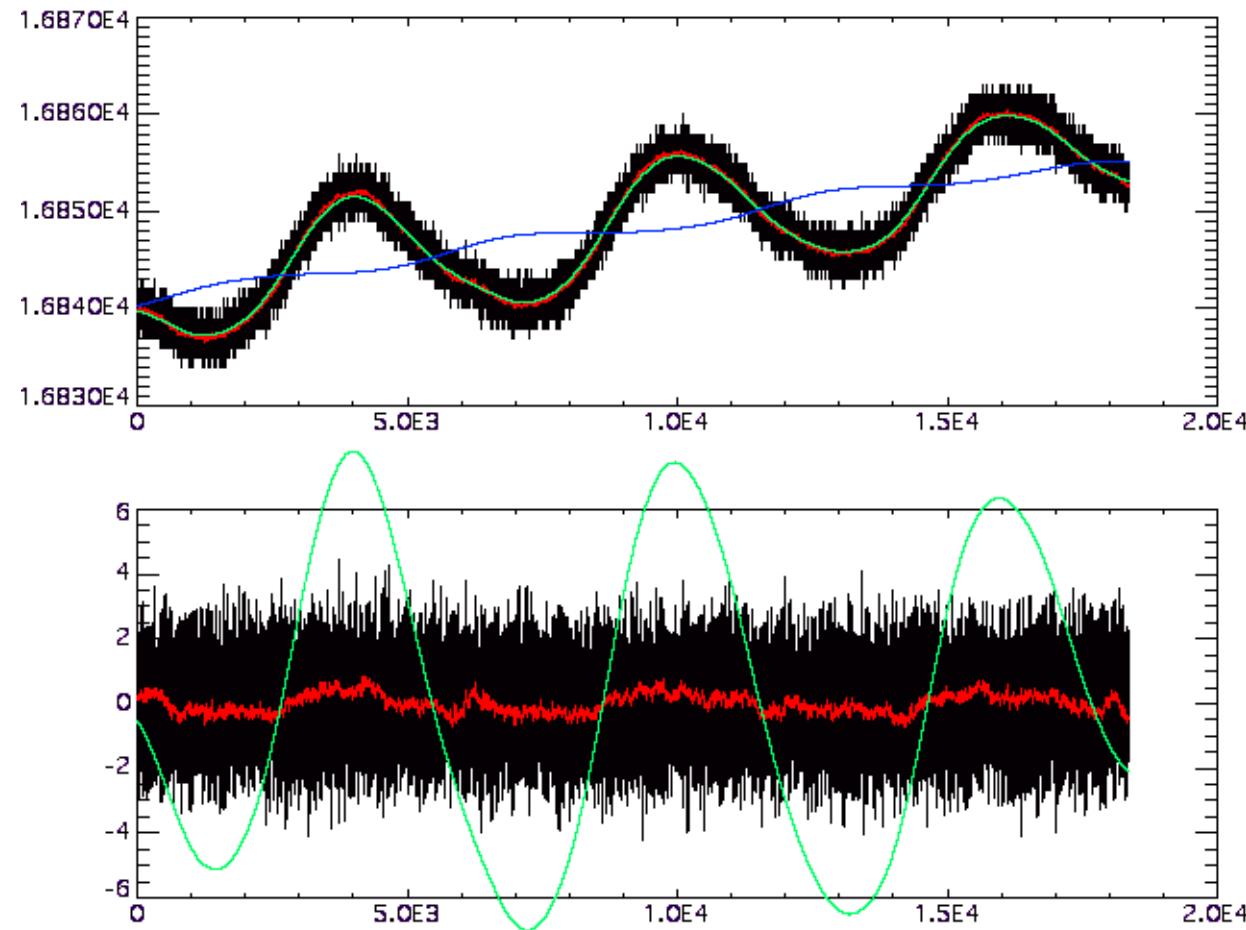
Noise Analysis: AMSU Ch. 13



Noise Analysis: AMSU Ch. 14



Noise Analysis: AMSU Ch. 15



Pointing Analysis: Approach



Method 1: Nadir stare mode data

- High sampling density \Rightarrow Instantaneous accuracy $\leq 1/20$ FOV
- Coast crossings: perpendicular \Rightarrow pitch error; oblique \Rightarrow roll error

Method 2: Full scan mode data

- Low sampling density \Rightarrow Instantaneous accuracy $\leq 1/2$ FOV
- Swath-edge perpendicular crossings \Rightarrow yaw error
- Requires many samples for good stats

Both methods: Compare counts or Tb with “landfrac”

- “landfrac” is DEM convolved with antenna function
- Looks like observations, scaled to [0 - 1]
- Makes it possible to work in scan coordinate system
- Results are directly translatable to instrument coordinates
 - Ground speed $\sim 0.54^\circ/\text{s}$ in instrument coordinates
 - Angular coordinates: pitch, roll, yaw



Pointing Analysis: Results

Only window channels can be analyzed using coastlines

- Good AMSU channels: 1, 2, 3, 15
- HSB: 2 only

AMSU results

- Pitch error: < 0.1xFOV (< 4 km at nadir)
- Roll error: not yet conclusive (est. < 0.2xFOV)
- Yaw error: not yet conclusive (est. < 0.3xFOV at swath edge)

HSB results

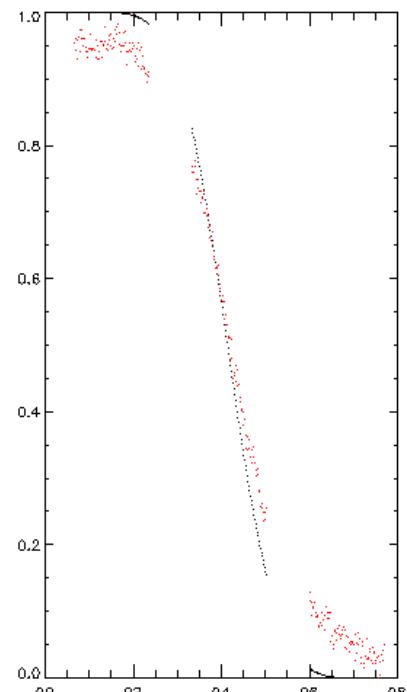
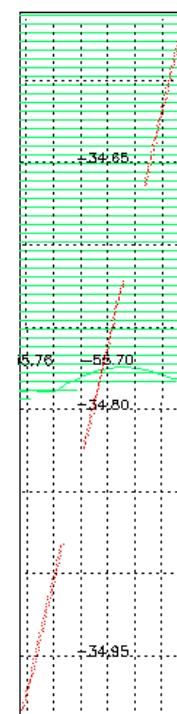
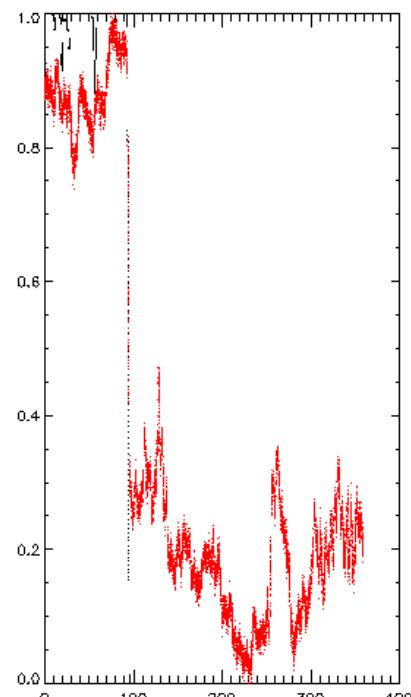
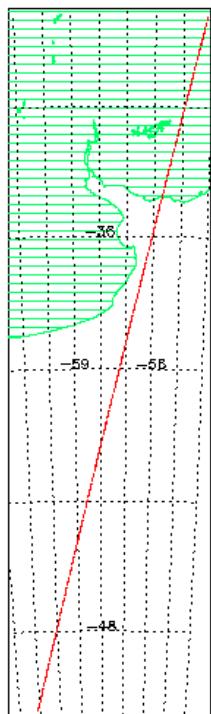
- Pitch error: < 0.1xFOV (< 1.5 km at nadir)
- Roll error: not yet conclusive (est. < 0.2xFOV)
- Yaw error: not yet conclusive (est. < 0.3xFOV at swath edge)



Pointing Analysis: Example 1

HSB channel 2: Perpendicular crossing (Uruguay)

Time error < 0.1 s \Rightarrow Pitch error < $-0.05^\circ \sim 5\%$ of FOV (1.1°)

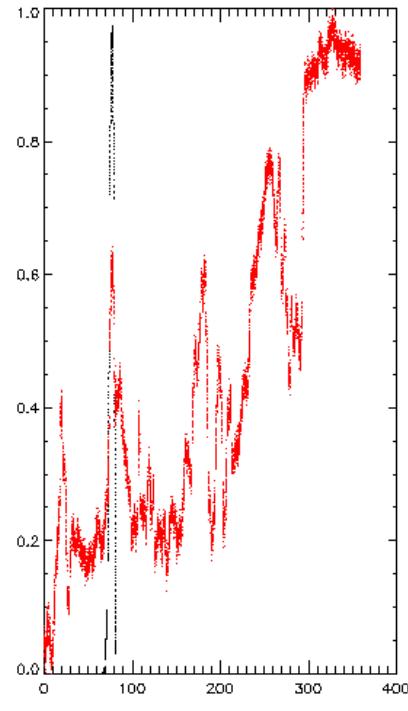
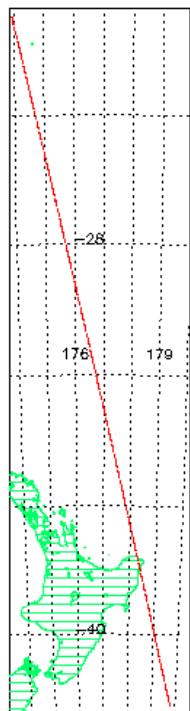




Pointing Analysis: Example 2

HSB channel 2: Oblique crossing (New Zealand)

Time error < 0.5 s; angle of attack $\sim 45^\circ \Rightarrow$ Roll error < $0.3^\circ \sim 20\%$ of FOV (1.4°)



Scan Bias Analysis: Approach



Scan bias

- Cause: off-nadir negative bias, as off-limb space enters sidelobes
- Remedy: apply scan dependent sidelobe corrections

Objective 1: Evaluate “sidelobe correction” applied in L1b

Objective 2: Evaluate “tuning coefficients” applied in L2

Method 1: Long-term stats of direct observations

- Pro: Results not clouded by any assumptions
- Con: Does not reveal absolute scan bias (only relative)
- Results: See following slides

Method 2: Short-term stats of “obs - calc”

- Pro: Reveals absolute scan bias
- Con: Includes model & “truth” errors
- Con: Noisy, due to small statistical sample
- Results: See examples by Rosenkranz, McMillin & others



Scan Bias Analysis: Results



AMSU-A1

- Scan bias is asymmetric
- Positive bias at *right* swath edge

AMSU-A2

- Scan bias is symmetric

HSB

- Scan bias is asymmetric
- Positive bias at *left* swath edge

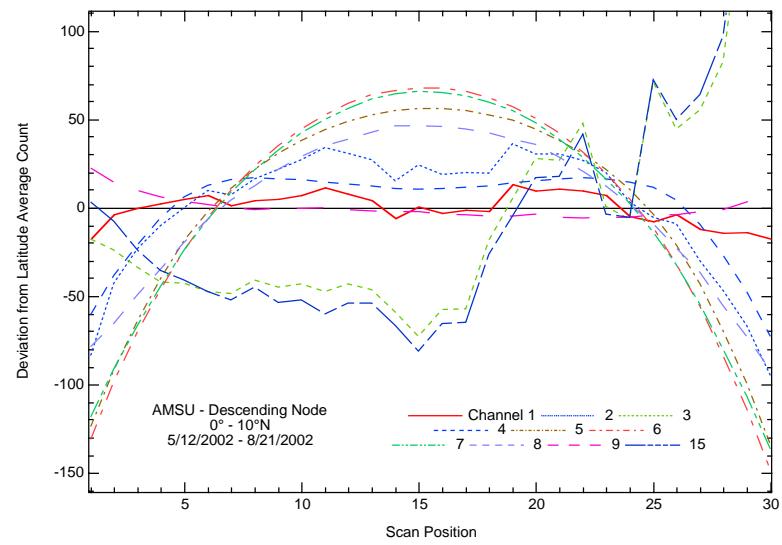
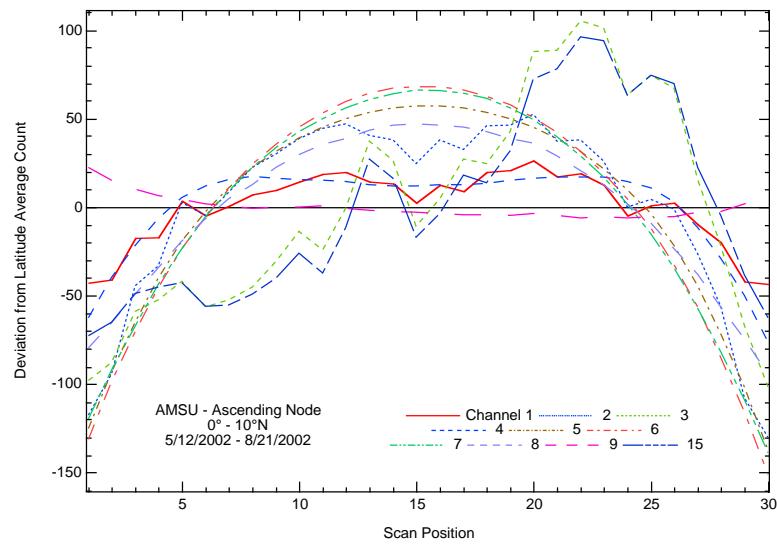
Hypothesis: may be caused by asymmetric S/C environment

- Under investigation

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Scan Bias Stats: AMSU

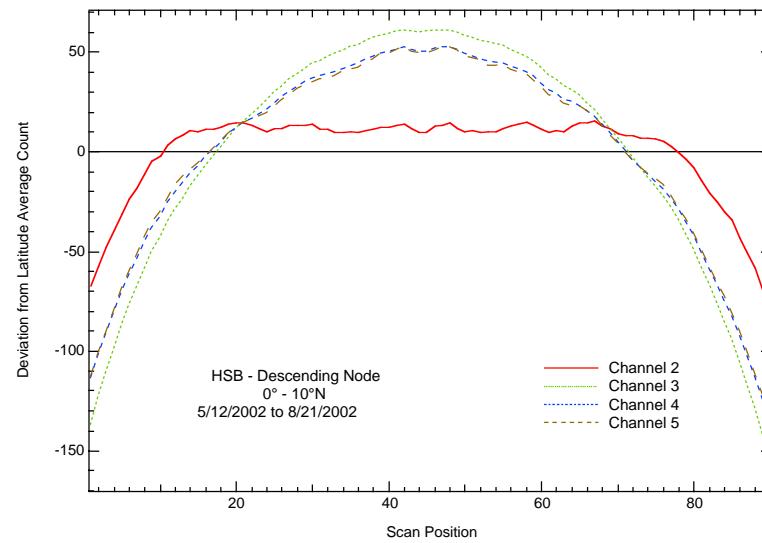
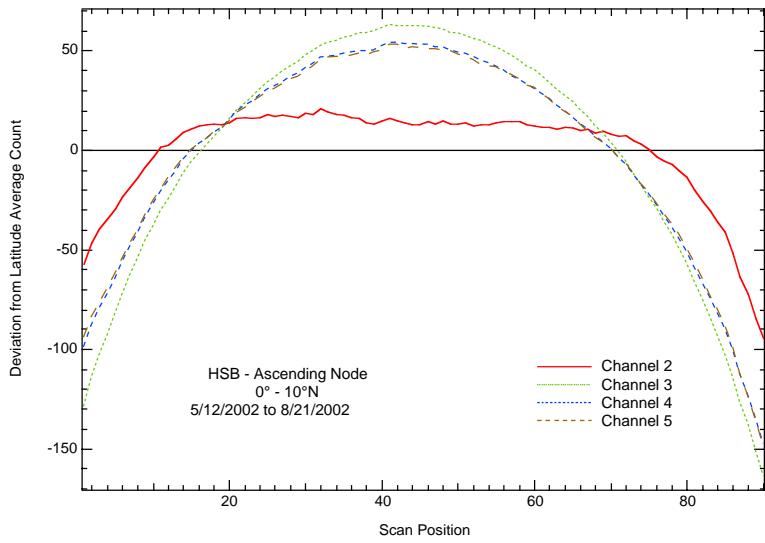


Near the equator

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Scan Bias Stats: HSB



Near the equator



Geometry

- May be visible in space-cal FOV
- Seasonal phenomenon
- Approximately half-moon when visible

Serendipity

- Unexpected large “noise” spikes seen during optimal space view analysis
- After some head scratching: check moon angles
 - Yup, the moon was transiting near a particular SV position
- Foresight during ATBD creation ⇒ We monitor the moon’s position
 - Angle between moon and each space view is computed in L1a

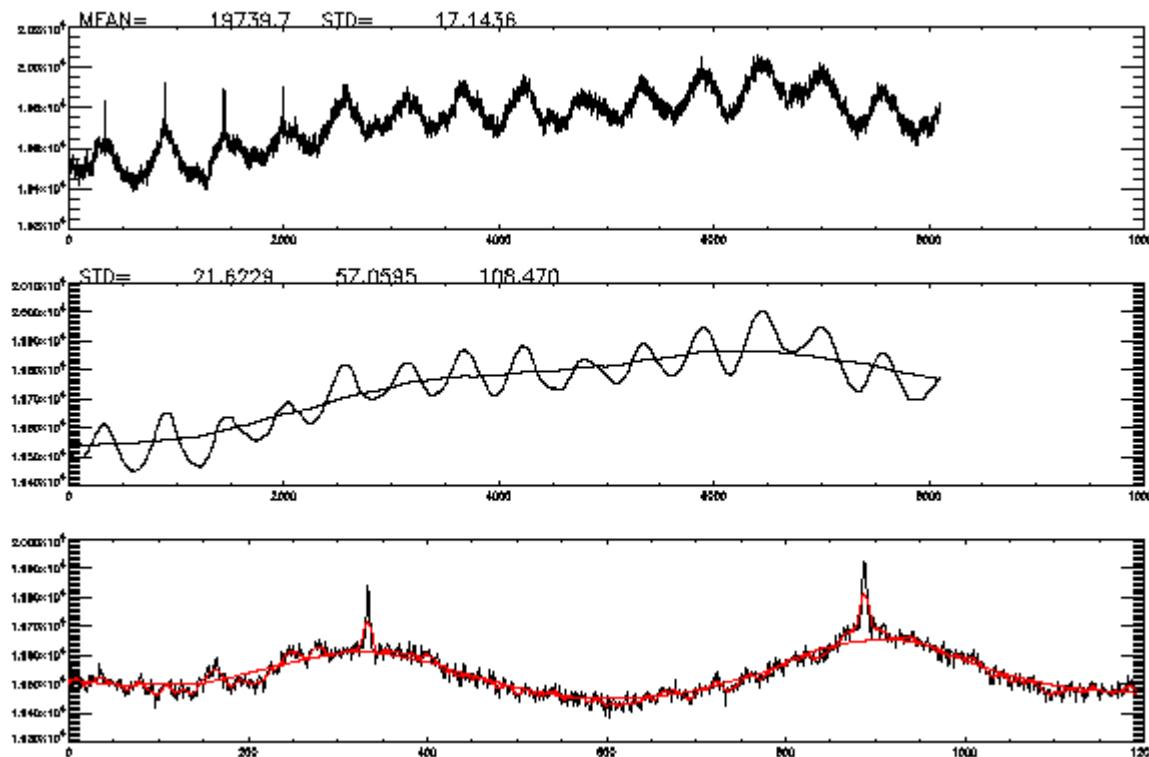
Results

- Moon got to within 0.4° of center of HSB FOV
- Used data to generate moon profile
 - Peak signal ~ 20 K @ 183 GHz, ~ 15 K @ 150 GHz
- Will use to update moon-in-FOV flag criteria
 - May use to supplement pointing analysis

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Moon in FOV: HSB SV Analysis



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HSB: Moon in Field of View

